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Scintillometry with non-uniform crosswind fields

Helen C. Ward, King's College London (& CEH Wallingford), London, United Kingdom; and J. G. Evans, H. A. R. De Bruin, and C. S. B. Grimmond

Scintillometry provides the opportunity to obtain spatially-averaged surface heat fluxes at a scale of hundreds of metres to kilometres. In addition, a measurement of the wind speed perpendicular to the path can be made, providing information along the length of the beam without requiring a network of *in situ* anemometers. Thus the potential as a ground-level validation tool for weather models and remotely-sensed satellite images, and the advantage over eddy covariance of measuring a larger area makes scintillometry an increasingly used technique, particularly over more and more complex land surfaces, including steep topography and in cities.

Due to the mixture of land uses, building heights and locally varying terrain, the land surface of urban areas is complicated and very different from the idealised locations where scintillometry has been well-tested. Therefore it is necessary to evaluate whether the theory can still be applied or whether adjustments are required; and to identify any warning signs in the data which might be indicative of particularly challenging conditions. The accuracy of the refractive index structure parameter (C_n^2), from which the heat fluxes are derived, and the quality of crosswind speed data need to be verified.

In this study, the effect of a non-uniform wind field along the path of a scintillometer was investigated. Theoretical spectra were calculated for a range of scenarios and the variance of the amplitude fluctuations at the scintillometer receiver was estimated. It was found that the refractive index structure parameter relationship with the scintillometer signal remained valid and invariant for spatially varying crosswinds but the spectral shape may change significantly, preventing accurate estimation of the crosswind speed from the frequency spectrum. On comparison with experimental data, it appears that non-uniform crosswind conditions could be responsible for previously unexplained features in the observed spectra. The results presented here demonstrate that, with caution, scintillometry can be appropriately used under conditions of varying crosswind speed.